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## (54) VEHICLE DISC BRAKES

(71) We, GIRLING LIMITED, a British Company, of Kings Road, Tyseley, Birmingham 11, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to actuators for fluid pressure actuated vehicle wheel brakes, and includes drum brake actuators and disc brake actuators.

More particularly, the invention relates to brake actuators comprising a cylinder having a brake applying piston exposed at its inner end to a pressure space within the cylinder and a lock actuator strut within the cylinder and operable to hold the piston in an extended condition to maintain the brake applied for parking.

One arrangement of this general form is disclosed in British Patent Specification 1288774. A disadvantage of the arrangements described and illustrated in that specification is that the seals between the pistons and the cylinder bore can be caused to travel excessively under high pressures if, for example, the pressure applied is sufficient to overcome the pre-stress in the spring means interposed between one piston and its associated thrust tappet.

It is well understood in the art that overtravel of piston seals at high pressures leads to early destruction of the seals.

The present invention provides a brake actuator in which this difficulty is avoided, by virtue of the fact that the (or each) piston comprises an annular outer part slidably sealed in the cylinder bore and an inner part telescopically and sealingly received in the outer part, with a pre-stressed spring device acting between the piston parts to transmit braking and reaction forces, and the lock actuator strut acts on

the inner piston part.

With this arrangement, it is possible to ensure that the seal between the outer piston part and the cylinder only experiences the relative travel necessary to apply the brake, and that any additional travel required to allow for deflection of the pre-stressed spring device is experienced only by the seal between the piston parts.

Preferably operation of the lock actuator strut is controlled by an auxiliary fluid pressure motor comprising a motor piston having one end exposed to pressure in an auxiliary cylinder space and its opposite end exposed to pressure in the said pressure space. Thus, the auxiliary piston may be neutralized by the application to both ends of equal pressures and rendered effective by the application of a greater pressure to the auxiliary cylinder space than in the main working space.

The lock actuator strut may comprise a screw threaded shank co-operating with a nut constituted by the inner piston part, the arrangement being such that a predetermined minimum movement of the piston in the brake applying direction frees the shank for rotation, whereas a shorter return movement causes it to lock, whereby the lock actuator strut also acts as an automatic wear adjuster for the brake applying piston.

In normal service brake operation of the brake, the inner piston part moves as one with the outer part and any necessary extension of the strut to compensate for friction lining wear takes place during the brake applying stroke. When the lock is to be applied, a pressure higher than normal is applied causing deflection of the pre-stressed resilient means (and possibly some structural deflection) the total deflection being greater than the axial play between the strut parts, so that when the strut is

locked and the service brake pressure is relieved, the piston is held applied by the resilient means reacting through the strut parts against the brake structure.

- 5 The invention also includes a power hydraulic system for use with such a brake construction, the system including an hydraulic pressure source service brake control means for admitting liquid at service  
10 braking pressure to the working space of the cylinder, and separate lock control means operable to control the supply of pressure to the said auxiliary piston and also to supply liquid at a higher pressure  
15 than the service brake pressure to the working space.

The invention is particularly suitable for use in disc brake actuators, and is described below mainly in that context but it  
20 will be understood by those skilled in the art that various features of the invention and the illustrated embodiment thereof will be applicable also to wheel cylinders for internal shoe drum brakes.

- 25 One form of disc brake and pressure system, both in accordance with the invention, will now be described, by way of example, with reference to the accompanying drawings, in which:—

30 Figure 1 is a sectional elevation of the disc brake; and

Figure 2 is a circuit diagram of the pressure system.

- The disc brake shown in Figure 1 is of the single sided caliper type, comprising a caliper structure 1 carrying a reaction pad 2 and an applied pad 3. The caliper has a piston bore 4 for a piston 6 having an inner part 7 telescopically engaged therein  
40 and retained by a circlip 8 against the expanding action of a prestressed stack of belleville spring washers 9. At its outer (left-hand end, the inner part 7 is keyed against rotation by its engagement at  
45 with the backing plate of brake pad 3. The part 7 has an axial bore internally screw-threaded to receive the threaded shank of a male strut part 12. The screw threads between the parts 7 and 12 are of reversible (fast-helix) form, and the parts 7  
50 and 12 together constitute an extensible strut assembly, as will be explained below.

- The strut part 12 has a head 13 presenting a frustro-conical clutch face 14 co-operating with a complementarily shaped clutch face formed in a disc-like clutch member 16 supported from the caliper structure by a thrust-bearing 17. The head 13 is normally pressed into frictional  
55 clutching engagement with the member 16 by a spring washer 18 acting against a thrust bearing 19 supported from the caliper structure by an annular retaining member 21. The clutch member 16 is formed  
60 on its outer periphery with gear teeth

and is normally held stationary in the caliper structure by a spring-loaded plunger 22 engaged between a pair of gear teeth. The plunger 22 is mounted in a plug 23 which is removable to permit release and  
70 rotation of the clutch member 16, in the event of the lock becoming jammed, due for example to failure of the hydraulic clutch release means to be described below.

The clutch release means comprises an auxiliary piston 24 working in a cylinder bore 26 coaxial with the main piston bore 4 of the caliper structure. The cylinder bore is open at one end so that the piston  
80 24 can bear, through a central domed projection, against the adjacent face of the head 13, while the other, closed, end of the bore is provided with a pressure inlet 27. A separate inlet, not shown, is provided  
85 for supplying fluid under pressure to the working space 28 of the piston bore 4 to act on the pistons 6 and 24. The piston 24 has two spaced circumferential seals and a leak passage 29 communicates with the  
90 space between the seals so that failure of either seal will be indicated by liquid leaking through the passage 29 and appearing at the exterior of the caliper body.

In use, service braking pressure is supplied to the working space 28 at a pressure  
95 which, acting over the full diameter of inner part 7, is insufficient to cause deflection of the spring washers 9, which therefore act as a solid strut in transmitting pad-applying forces to the pad 3,  
100 the brake acting in this respect as a conventional hydraulic disc brake.

When the brake is actuated from a hydrostatic pressure system, the operation  
105 is as follows: In normal, service brake operation, no pressure is applied to the cylinder bore 26, so that the strut part 12 is resiliently biased into clutching engagement with clutch member 16. When  
110 service brake pressure is applied to the working space 28, the piston 6 and inner part 7 move in unison in the pad-applying direction, and the axial thread clearance between the parts 7 and 12 is taken up.  
115 This clearance is sufficient to provide normal pad-to-disc running clearance. The part 7 then tends to pull the part 12 off clutch member 16, and if there is some wear of the pads to be compensated, the  
120 strut part 12 will be rotated in a sense to extend the length of the strut. On brake pressure release, the part 12 will be re-engaged with the clutch member 16 to lock the part 12 against rotation and retraction  
125 of the piston 6 and inner part 7 will be checked when the thread clearances are taken up in the reverse direction.

If the parking lock is to be applied, a higher pressure is applied to the working  
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space 28 causing compression of the spring washers 9 and possibly some structural deflection, the total deflection being in excess of the axial thread clearance between the strut parts 7 and 12, so that upon release of such pressure, the inner part is locked in a position in which the washers are held deflected, the spring force stored in the washers therefore applying an actuating or applying force to the piston 6, to hold the pads applied.

To release the parking lock, the same higher pressure is again applied to the working space 28 and a still higher pressure is supplied through inlet 27 to the closed end of bore 26, thus to the inner end of piston 26. The piston, which is subjected to a lower pressure at its opposite end, accordingly moves out of its bore to engage the head 13 of strut part 12 and thereby disengage it from clutch member 13. The pressure in working space 28 is then relieved, the pad return forces and force in spring washers 9 being transmitted through the reversible screw threads to strut part 12 which accordingly rotate, spinning on the domed projection of piston 24 to permit axial return movement of the inner part 7 to its illustrated position. The pressure in cylinder bore 24 is thus relieved to complete the cycle and return the brake to its normal, passive condition.

For operation with a power hydraulic pressure system, we prefer to supply during service brake actuation, a higher pressure to cylinder bore 24, so that the strut part 12 is free to spin, without waiting for the clutch clearances to be opened up. In this way it is possible to work with smaller thread clearances and therefore to lock in higher braking efforts than in the hydrostatic mode described above. To lock the brake a boosted pressure is applied to the working space 28 to deflect the spring washers 9, the pressure in cylinder bore 24 then being relieved to cause the clutch to engage and finally the pressure in the working space 28 is relieved.

The lock is released by applying the boosted pressure to space 28 and a higher pressure to cylinder bore 24. The boosted pressure is then relieved, and when the parts have returned to their normal position the pressure in bore 24 is relieved to allow re-engagement of the clutch.

A presently preferred form of power hydraulic system for operating in accordance with the last described mode is illustrated diagrammatically in Figure 2.

The system comprises a liquid reservoir R supplying two pumps P in turn feeding pressure liquid accumulators A. The accumulators are connected to respective foot pedal controlled valves FCV each connected to respective working spaces of

front and rear wheel brake calipers FB and RB. The valves FCV are also connected to respective hand control valves HCV, the exhaust lines of which lead back to the reservoir R.

Second lines from the accumulators lead to the respective valves HCV and third lines to lock control valves L which may be integral with, or as indicated, linked with the hand control valves HCV. The downstream connection of the valves L are to the respective cylinder bores of the lock release or auxiliary pistons, corresponding to the bores 24 of Figure 1.

In normal operation, service braking pressure is metered by the valves FCV to the working spaces of the wheel brakes, and through the valves L to the lock release cylinders of the brakes.

For a parking operation, the hand control valves HCV are operated (instead of the foot control valves) first to direct accumulator pressure through the foot control valves to the wheel brake working chambers, then to release pressure in the lock release cylinders and finally to relieve the pressure in the working spaces of the wheel brakes. It will be understood that the valves FCV apply a flow restriction which drops the pressure transmitted from the accumulators to a value between the full system pressure and the maximum pressure which is transmitted in service brake operation.

The system is shown as supplying four twin cylinder, single sided calipers, but this is obviously subject to variation to suit individual vehicle requirements.

For example, the construction is readily applicable with minimal modification, to a wheel brake cylinder of the single ended type having one piston working in a cylinder body closed at one end, or with further modification to a double ended cylinder body of the type having a single pressure space and opposed pistons at opposite ends of the pressure space. In such a case, the fixed clutch face 14 of the above described actuator would be formed on one piston or on a component normally fast with that piston but preferably releasable to permit rotation of the clutch face in the event of the lock actuator becoming jammed.

In each case a relatively compact construction can be obtained, due mainly to the fact that the full diameter of the (or each) piston is available as an effective area, in contrast to the annular pistons found in British Patent Specification 1288774.

Although described above in detail with respect to disc brakes, features of the invention are also applicable to drum brakes.

It will be noted that the pre-stressed re-

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silient means (the belleville washers 9) transmit normal braking loads without deflection. This is in contradistinction to some prior proposals in which mechanical deflection of standard brake components is employed to provide compliance for ensuring that the locking load is retained in the strut, and others in which pre-stressed means are designed to yield to provide against overloading of the strut due to contraction of other brake components during cooling.

#### WHAT WE CLAIM IS:—

1. A brake actuator for a fluid pressure actuated vehicle wheel brake, comprising a cylinder having a brake applying piston exposed at its inner end to a pressure space within the cylinder and a lock actuator strut within the cylinder operable to hold the piston in an extended position to maintain the brake applied for parking wherein the piston comprises an annular outer piston part and an inner piston part telescopically received in the outer piston part, with pre-stressed resilient means acting between the said parts and capable of transmitting braking and reaction forces between the two parts, and the said lock actuator acts on the inner piston part, an outer pressure seal being provided between the outer piston part and the cylinder and an inner seal being provided between the two piston parts.

2. A brake actuator as claimed in claim 1, comprising clutch means for controlling operation of the strut and an auxiliary fluid pressure actuated motor controlling operation of the clutch, the motor comprising an open ended auxiliary cylinder and a motor piston extending through the open end of said cylinder, and the motor piston having one end exposed to pressure in the auxiliary cylinder and an opposite end exposed to pressure in the said pressure space.

3. A brake actuator as claimed in claim 1 or 2, wherein the strut includes a screw threaded shaft threadedly engaged in the inner piston part with limited axial play between the shaft and inner piston part; the actuator including a spring biased clutch normally preventing rotation of the shaft relative to the inner piston part and wherein normal service brake actuation to effect displacement of the brake ap-

plying piston in excess of said axial play is effective to release said shaft to rotate and thereby increase its effective length, whereby to cater for automatic brake lining wear adjustment.

4. A brake actuator according to claim 3, wherein the shaft has a friction clutch head engageable with a non-rotary clutch face, the said clutch head being spring biased into engagement with the clutch face in a direction opposite to the brake applying direction of movement of the brake applying piston.

5. A brake actuator for a fluid pressure actuated vehicle disc brake comprising a brake reaction structure defining a cylinder bore, a brake pad applying piston in said cylinder bore, the said piston comprising an annular outer piston part slidably sealed in the bore and an inner piston part telescopically sealed in the outer piston part; pre-stressed resilient means located in the piston and acting between the piston parts to resist telescoping thereof under braking and reaction loads; a lock actuator strut having a screw threaded shaft threadedly engaged in the inner piston part and a clutch head remote from the inner piston part; a fixed clutch face associated with the reaction structure; clutch spring means biasing the clutch head into frictional clutching engagement with the clutch face; an auxiliary motor cylinder formed in the reaction structure and aligned axially with the strut; a motor piston in the cylinder and having an outer end engageable with the strut, and means for supplying fluid pressure to the motor cylinder to urge the motor piston into engagement with the strut in a sense to break clutching engagement between the clutch head and the clutch face.

6. A brake actuator according to claim 4 or 5, wherein the clutch face is formed on a normally stationary member which is manually releasable to permit rotation thereof with the shaft.

7. A brake actuator substantially as herein described with reference to the accompanying drawings.

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COMPLETE SPECIFICATION

2 SHEETS

This drawing is a reproduction of the Original on a reduced scale.

SHEET 2

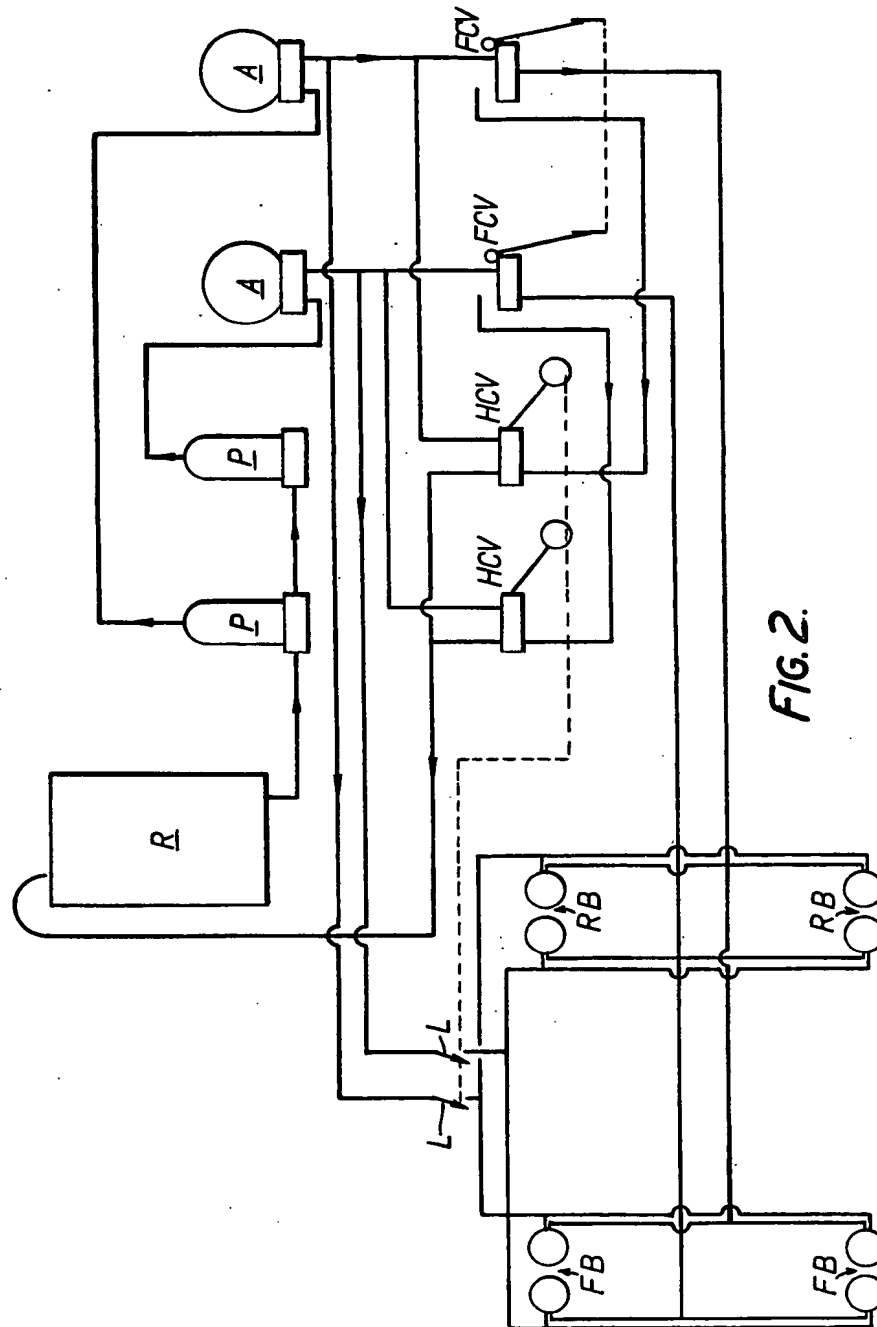


FIG. 2.

